Operando CXDI of a single PtRh alloy nanoparticle under catalytic reaction conditions

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Oxide supported noble metal alloy nanoparticles provide an excellent model system for the investigation of underlying processes during catalytic reactions [1,2,3].

The instrumentation provided at DESY-NanoLab allows for the well-defined growth of noble metal alloy nanoparticles in ultrahigh vacuum using molecular beam epitaxy. Further structural and geometric properties of the nanoparticles are determined using x-ray reflectivity, x-ray diffraction, scanning electron microscopy (SEM), scanning tunnelling microscopy, and atomic force microscopy (AFM).

The advanced nano-object transfer and positioning software developed in the Nanoscience Foundation and Fine Analysis (NFFA) project allows for the investigation of single nanoparticles at different instruments. Using this, coherent x-ray diffraction imaging (CXDI) on single nanoparticles was performed at ESRF-ID01 under controlled oxidizing and reducing ambient conditions ($2\ CO+O_2 \rightarrow 2\ CO_2$). The CXDI procedure successfully retrieved the real space geometric properties from reciprocal space information. The reconstruction fits the particle geometry given by AFM and SEM measurements. Furthermore, CXDI revealed changes in the structural properties of the nanoparticle dependent on the different gas environments in the reactor. The ambient conditions in the reactor have been controlled using a back-pressure controller and a residual gas analyser (mass spectrometer).

References:
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